

# **Stress Testing the Household Sector Using Microdata**

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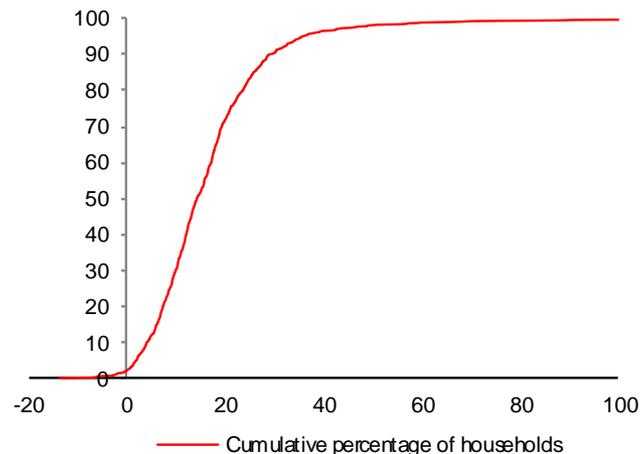
September 18, 2014

- Data come from Czech Statistical Office (CZSO) – **Household Budget Survey (HBS) 2012**
  - Some 2 900 HHs – divided into 5 income quintiles, because overindebtedness greatly depends on income
  - Some 1 100 HHs with a loan
  - Higher income quintiles consist of more HHs with a loan
- Why to use microdata?
  - Fallacy of composition
  - Structure of debt is important
  - Weak points can be identified
  - More observations than in macroeconomic time-series
- 2013 microdata were „nowcasted“ based on 2012 data and public aggregate 2013 data

- Stress tests of households are integrated with stress tests of banks in the sense that it uses the same shocks to aggregate variables
- In the case of realisation of the Stress Scenario (SS) Europe in Deflation and Baseline Scenario (BS) in 2014, however, the simulation of future distress is not performed by applying the above methods to the 2013 simulation results. This is because the 2013 calculations do not provide an unambiguous assignment of household members' labour market state or income; they only give the probabilities of each state. The 2014 results are thus obtained by calculating the cumulative changes in the variables under study for the entire period from the end of 2012 to the end of 2014 in one step.
- BS:  $\Delta$  unemploy. r. = - 0.4 pp  $\Delta$  ir = 0.2 pp  $\% \Delta$  CPI = 2.9 %  $\% \Delta$  w = 2.9 %
- SS:  $\Delta$  unemploy. r. = 1.0 pp  $\Delta$  ir = 0.2 pp  $\% \Delta$  CPI = 0.7 %  $\% \Delta$  w = -1.9 %

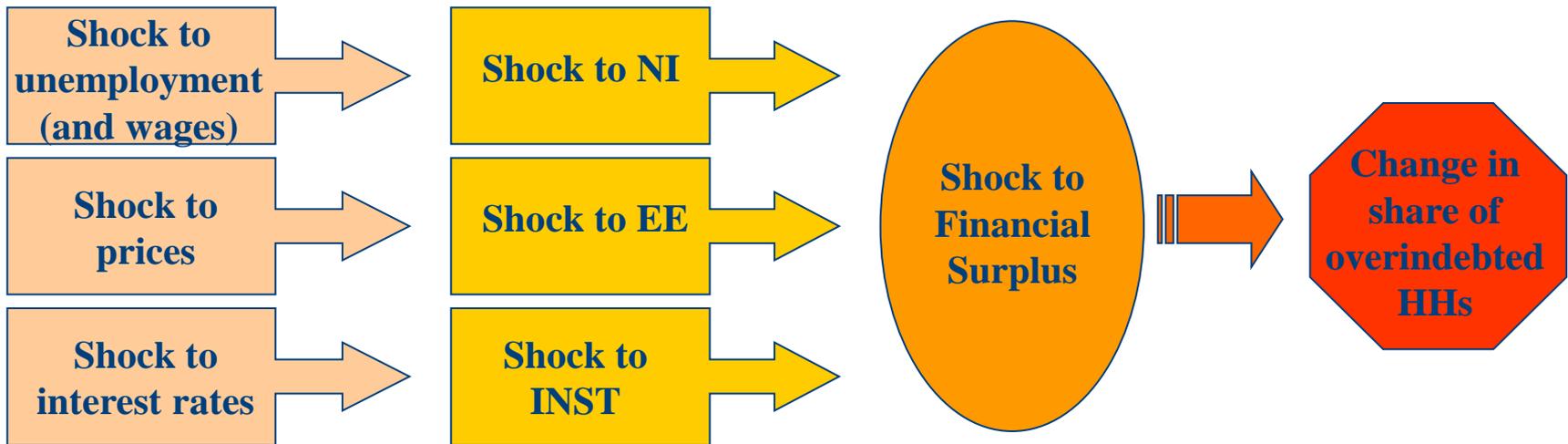
- Definition of an overindebted household
  - $FS = NI - EE - INST < 0$  CZK/month  $\rightarrow$  overindebted HH
  - FS = Financial Surplus
  - NI = Net Income, EE = Essential Expenditure, INST = Installments

**Figure 2: Cumulative Distribution of Financial Surplus**  
(thousands CZK/month on x-axis; % on y-axis )



Source: HBS 2012, authors` calculations

Note: Only households with debt are included.



- Shocks not covered
  - **Exchange rate shock** – important mainly because of FX denominated loans, but Czech HHs almost do not have any
  - **Residential real-estate price shock** – decreases wealth of HHs, but Czech HHs hold them mainly as own lifetime residence, thus not incorporating its price into their decisions

- Adult persons are divided into 3 groups according to labour status
  - **Employed (E)** – can stay in E or become U
  - **Unemployed (U)** – can stay in U or become E
  - **Out of Labor Market (O)** – stays in O
- If the person becomes U unemployment benefit is assigned to (s)he according to her age
- If the person becomes E potential wage from Heckman model is assigned to (s)he
  - Heckman model (1979) corrects for selection bias by including an additional variable (relating to probability of being unemployed) to the equation of wage determination (wage is in logs)

## Probit model of unemployment

$$p(u_i = 1 | x_i) = \Phi(z_i),$$

$$z_i = \alpha + \beta x_i,$$

$p(u_i = 1 | x_i)$  = probability that person  $i$  is unemployed given its characteristics  $x_i$

$\alpha$  = constant

$\beta$  = vector of coefficients

$\Phi$  = CDF of standard normal distribution -  $N(0;1)$

- Dependent variable is a dummy which equals 1 if the person is in U category or 0 if the person is in E category
- Explaining variables are mainly socio-demographic dummies
- Net income of HH is not included, because of the endogeneity problem (only the remaining income of the HH in logs is included)
- Persons in O category are not included
- Standard errors corrected for clusters (cluster = adult persons in HH)
- McFadden's R-squared = 27.9 %, Gini coefficient = 73.8 %

- The constant of the probit model is risen in order to reach the unemployment rate ( u.r. = average  $p(u_i|x_i)$  ) given for the scenario
- The results of the model is not an unambiguous assignment of labor status of every adult person - the results are probabilistic
- After applying the relevant scenario, we assign to each person a probability of being unemployed after the shock to unemployment. For every possible combination of employment and unemployment for the household head and the second adult, we calculate the household's NI and the resulting FS and use the this to assess whether the household in the given state is distressed (a binary variable taking a value of either 0 or 1). The resulting distress is calculated for each household as the average of these binary variables weighted by their probability of occurrence.
- We simultaneously assume that the change in labour market state is independent in the case of two adults in one household.

- EE = food + health + energy + eventually rent in the data for every particular household
- Assumptions of elasticities:

**Table 1: Elasticities of demand in categories of essential goods (%)**

	Price elasticity	Income elasticity
<b>Food</b>	-0,68	0,89
<b>Energies</b>	-0,96	0,59
<b>Health</b>	-0,72	0,84

Note: Uncompensated price (income) elasticities showing a percentage change in quantity demanded if price (income) increases by 1 percent.

Source: Dybczak et al. (2010)

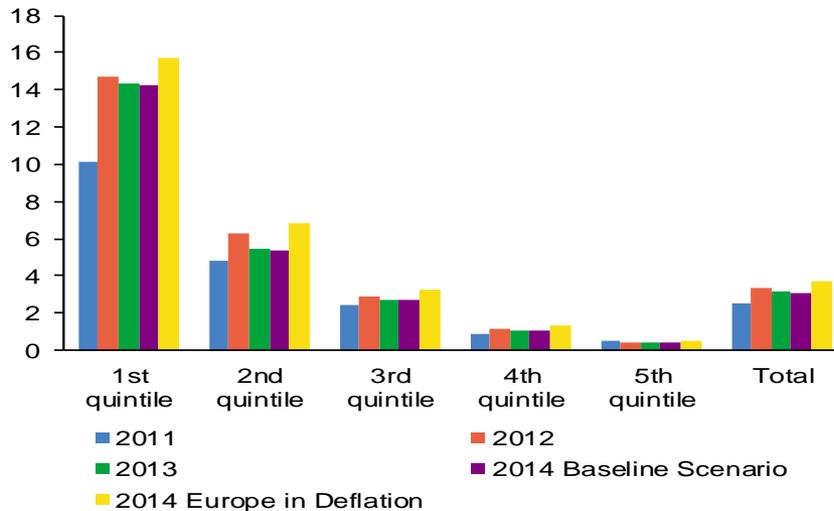
- Assumption of totally inelastic rents
- Impact mainly on low income HHs because of:

Quintile	Ratio of EE to NI
1st	61.8%
2nd	51.1%
3rd	44.9%
4th	40.6%
5th	32.2%

- Three categories of loans
  - Housing loans (mostly IR fixed for 3 or 5 years)
  - Consumer loans (mostly IR fixed for the whole repayment period)
  - Other
- Only value of installment included in the dataset
  - We need to estimate average interest rate and tenor of each category of loans from aggregate data before the simulation and in every scenario
  - Same monthly amount of every repayment of a loan is assumed
  - For one-off shocks the coefficient determining the percentage of mortgages subject to re-fixation over the next year is 0.51
  - Net Present Value method used to calculate new installments after the shock to interest rates
  - Long-term effects – all loans are refixed, short-term effects – consumer loans not refixed at all, 51 % of mortgages refixed

## Share of overindebted households by income quintile

(%)



Source: CZSO 2011 and 2012 Household Budget Statistics, CNB calculation

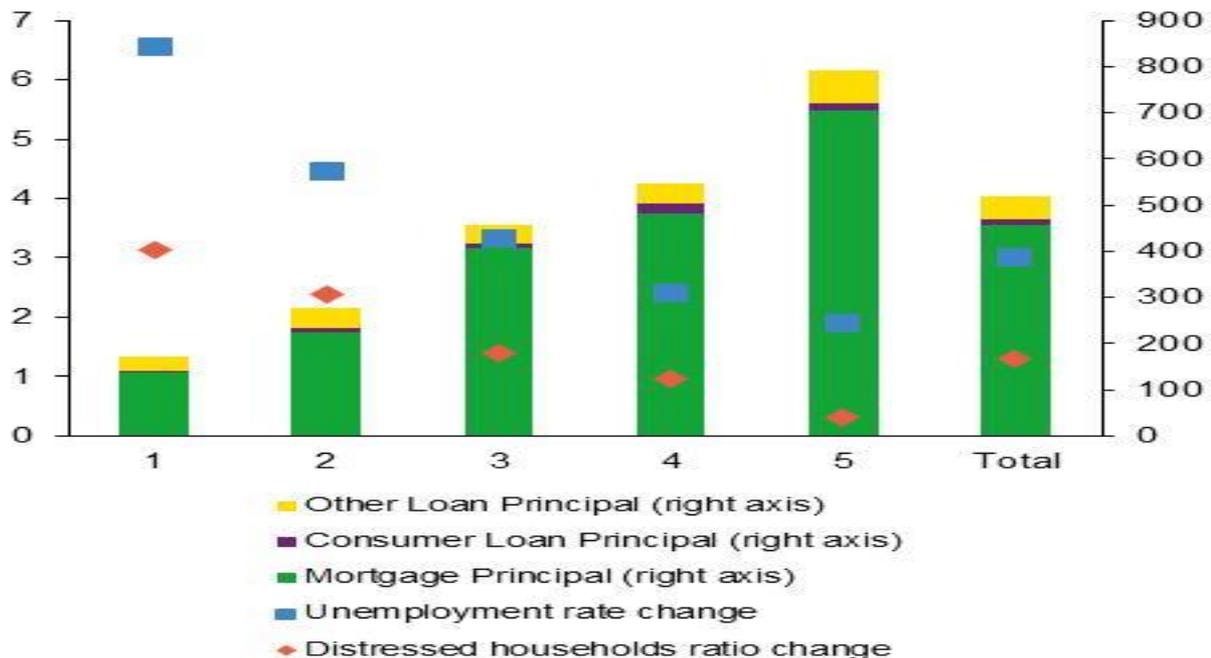
Note: The shares are given for households that have some sort of loan. However, the income quintiles are based on the full sample of households.

## • Conclusions

- Low-income HHs are most endangered
- Low-income HHs are most sensitive to stress scenario
- Share of distressed HHs generally rises in all quintiles
- Overindebtedness is not only dependent on income but also on age, education, sex, labor status, family status, etc. (however these factors are in fact correlated with the income)

- Why the overindebtedness ratio around 15 % among low-income HHs is not a threat to FS?
  - Being classified as overindebted does not necessarily mean you will default on your repayments, the probability is for example 40%
  - According to the Lorenz curve the 1<sup>st</sup> income quintile has to pay only 3-4% of repayments (even less of principal)- meaning it is not a threat to aggregate FS (no significant impact on banks' balance sheets)
  - The 0 CZK/month threshold is somewhat arbitrary and setting it higher changes the results

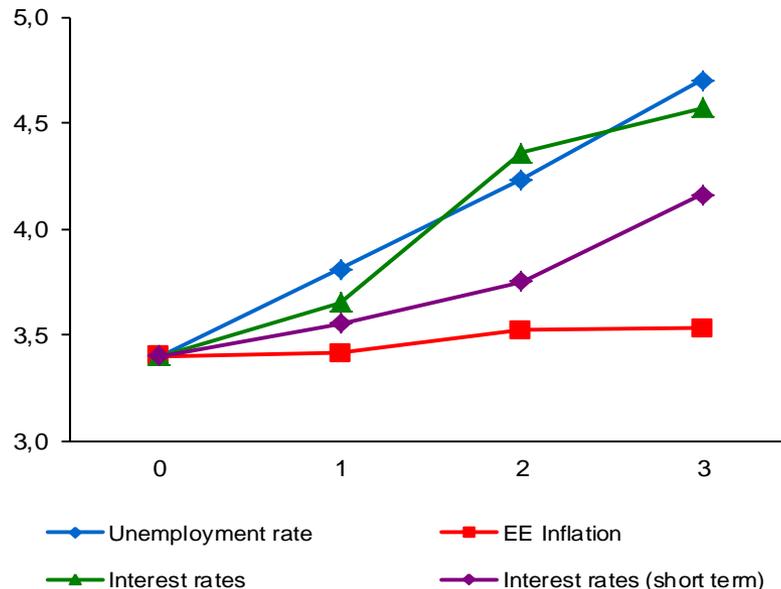
Reaction of Households to 3 Standard Deviation Shock to Unemployment Rate  
(percentage points; CZK thousands)



- Also one-off shocks to separate variables considered
  - Shocks magnitude measured by standard deviations (SD)
  - $SD_{unemploy. r.} = 1.39$  pp,  $SD_{infl.} = 1.73$  pp,  $SD_{IR} = 0.74$  pp

### Percentage of Distressed Households in response to macroeconomic shocks

(% on x-axis; standard deviations on y-axis)

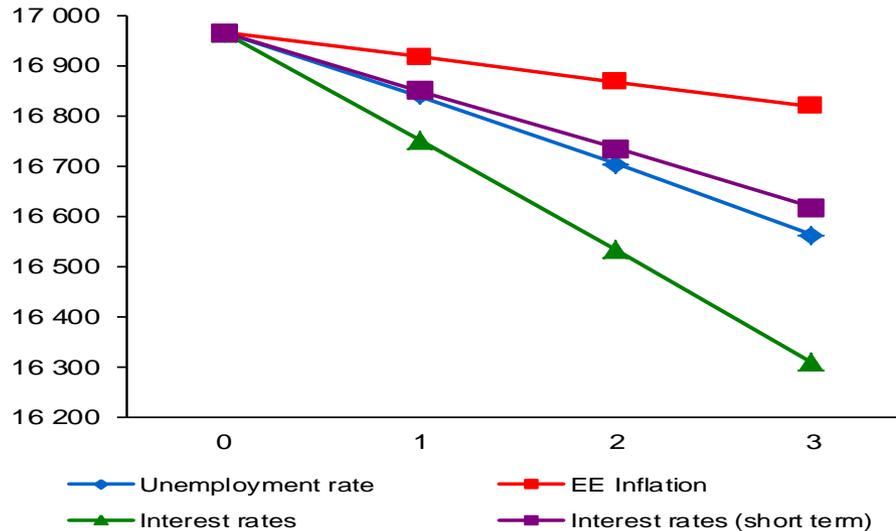


Source: HBS 2011 and 2012, authors` calculations

Note: Average ratio of distressed households relative to the end of 2012 in the event of shocks of the size of 1–3 standard deviations. Shocks to unemployment rate, interest rate (short-term and long-term effects), and to essential expenditure (EE) are considered. Values at zero on the x-axis correspond to the starting point at the end of 2012.

## Average Financial Surplus in Response to Macroeconomic Shocks

(CZK/month on y-axis; standard deviations on x-axis )



Source: HBS 2011 and 2012, authors` calculations

Note: Average financial surplus relative to the end of 2012 in the event of shocks of the size of 1–3 standard deviations. Shocks to unemployment rate, interest rate (short-term and long-term effects), and to essential expenditure (EE) are considered. Values at zero on the x-axis correspond to the starting point at the end of 2012.

- Why IR shock has smaller impact on overindebtedness although higher on Financial Surplus (FS) than unemployment shock?
  - In absolute terms higher-income HHs have much higher installments
  - Therefore FS changes more in absolute terms
  - But original FS of higher-income HHs is much higher meaning, that even after higher shock to FS it does not fall below 0 in most cases

- Old data
- Some important stock variables missing (debt outstanding, assets, interest rate)
- The test works well for lower income households where minimum living costs constitutes significant part of the income. Default of middle and high income households is of a different nature (equity and other asset prices important)
- Only 1 100 HHs with a loan in data from CZSO
- Participation in Household Budget Survey can be correlated with observed variables, it can mean, that the data are not a random draw from the whole population and thus are not fully representative, the sample is representative with respect to socio-demographic variables, not necessarily with respect to financial variables
- Time dimension is suppressed (only pseudo-panels possible)
- **In order to overcome these issues an improvement of Household Budget Survey would be needed**

- ALBACETE, N., FESSLER, P. (2010): *Stress Testing Austrian Households*, Financial Stability Report 19, June, OeNB.
- DANMARKS NATIONALBANK (2007): *Financial Stability Report*.
- DJOUDAD, R. (2010): *The Bank of Canada's Analytic Framework for Assessing the Vulnerability of the Household Sector*, in Financial System Review, Bank of Canada, June.
- **GALUŠČÁK, K., HLAVÁČ, P., JAKUBÍK, P. (2014): *Stress Testing the Private Household Sector Using Microdata*, Working Paper No. 2/2014, Czech National Bank.**
- HECKMAN, J. J. (1979): *Sample Selection Bias as a Specification Error*, *Econometrica* 47(1), pp. 153–161.
- HERRALA, R., KAUKO, K. (2007): *Household Loan Loss Risk in Finland – Estimations and Simulations with Micro Data*, Bank of Finland Research Discussion Papers, No. 5/2007.
- HOLLÓ, D., PAPP, M. (2007): *Assessing Household Credit Risk: Evidence from a Household Survey*, Magyar Nemzeti Bank Occasional Papers, No. 70.
- JAKUBÍK, P. (2010): *Household Response to the Economic Crisis: Micro-simulation for the Czech Economy*, IFC Working Papers, No. 6, Irving Fischer Committee on Central Bank Statistics, Bank for International Settlements, December.
- JOHANSSON, M., PERSSON, M. (2006): *Swedish Households' Indebtedness and Ability to Pay – A Household Level Study*, Penning – Ochvalutapolitik 3/2006, pp. 24–41.
- KARASULU M. (2008): *Stress Testing Household Debt in Korea*, IMF Working Paper No. 08/255, November.

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- IR shock has similar impact as in Austria, but the impact is much higher than in Sweden probably due to lower debt burden (for example Interests/Net income) in Sweden

### *Impact of Interest Rate Shock*

	1	2	3
Czech Republic	5.9 (8.8)	14.7 (38.2)	29.4 (47.1)
Sweden	1.6 (4.8)	4.8 (12.7)	6.3 (15.9)
Austria	6.5 (9.8)	20.7 (29.3)	30.4 (41.3)

*Note:* Short-term effects of the interest rate shock (partial refixation of loans); long-term effects (full refixation of loans) in parentheses. Increase in the incidence of distressed households in per cent from the no-shock scenarios. The size of the shock is in percentage points. The results for the Czech Republic are from this paper, those for Sweden are from Johansson and Persson (2006) and those for Austria are from Albacete and Fessler (2010).

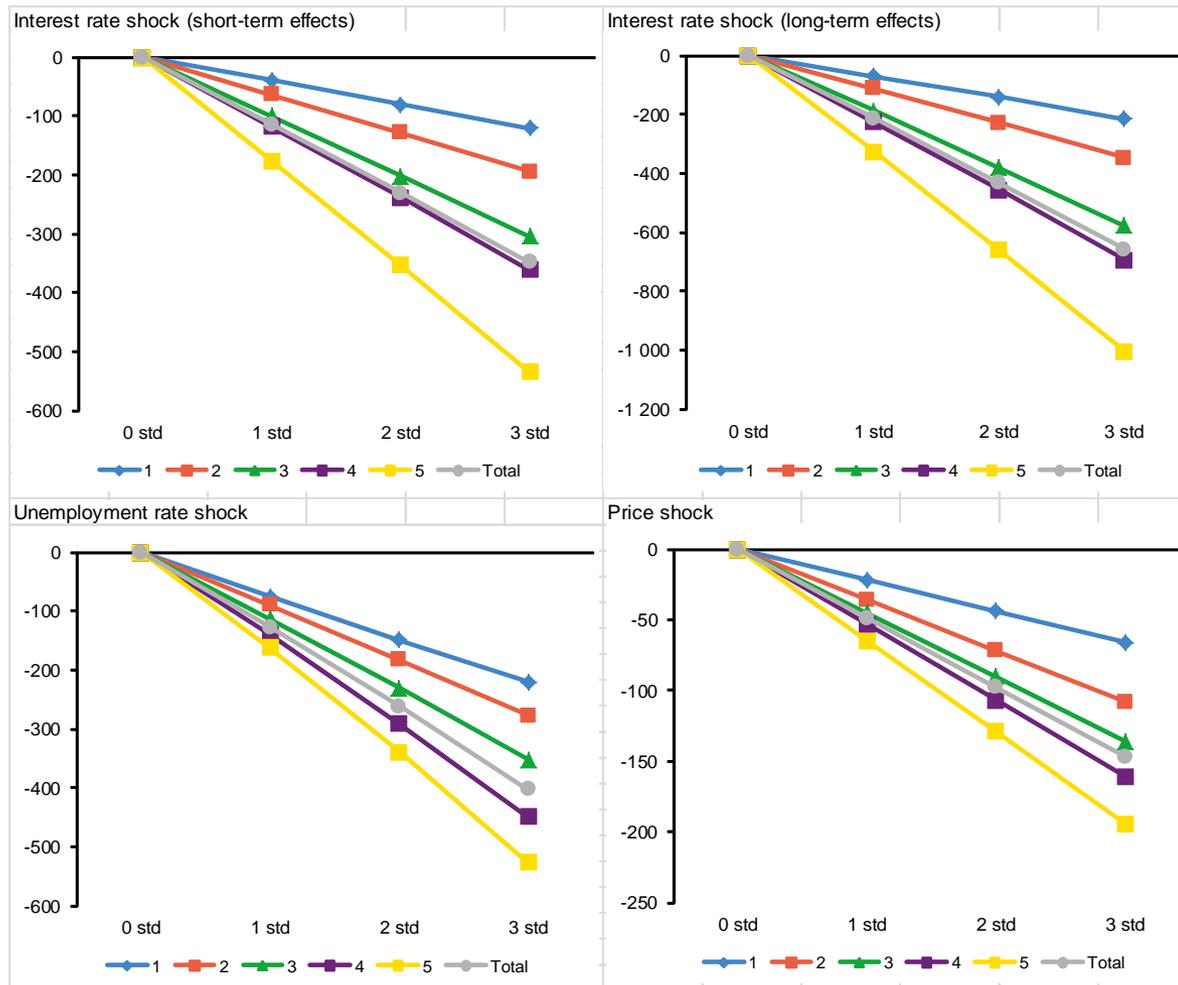
- Unemployment shock has much higher impact than in Austria and Sweden probably due to inclusion of spouses in our estimations and due to different duration and value of unemployment benefits

### *Impact of Unemployment Rate Shock*

	1	2	3
Czech Republic	8.8	17.6	26.5
Sweden	3.2	4.8	6.3
Austria	1.1	1.1	2.2

*Note:* Increase in the incidence of distressed households in per cent from the no-shock scenarios. The size of the shock is in percentage points. The results for the Czech Republic are from this paper, those for Sweden are from Johansson and Persson (2006) and those for Austria are from Albacete and Fessler (2010).

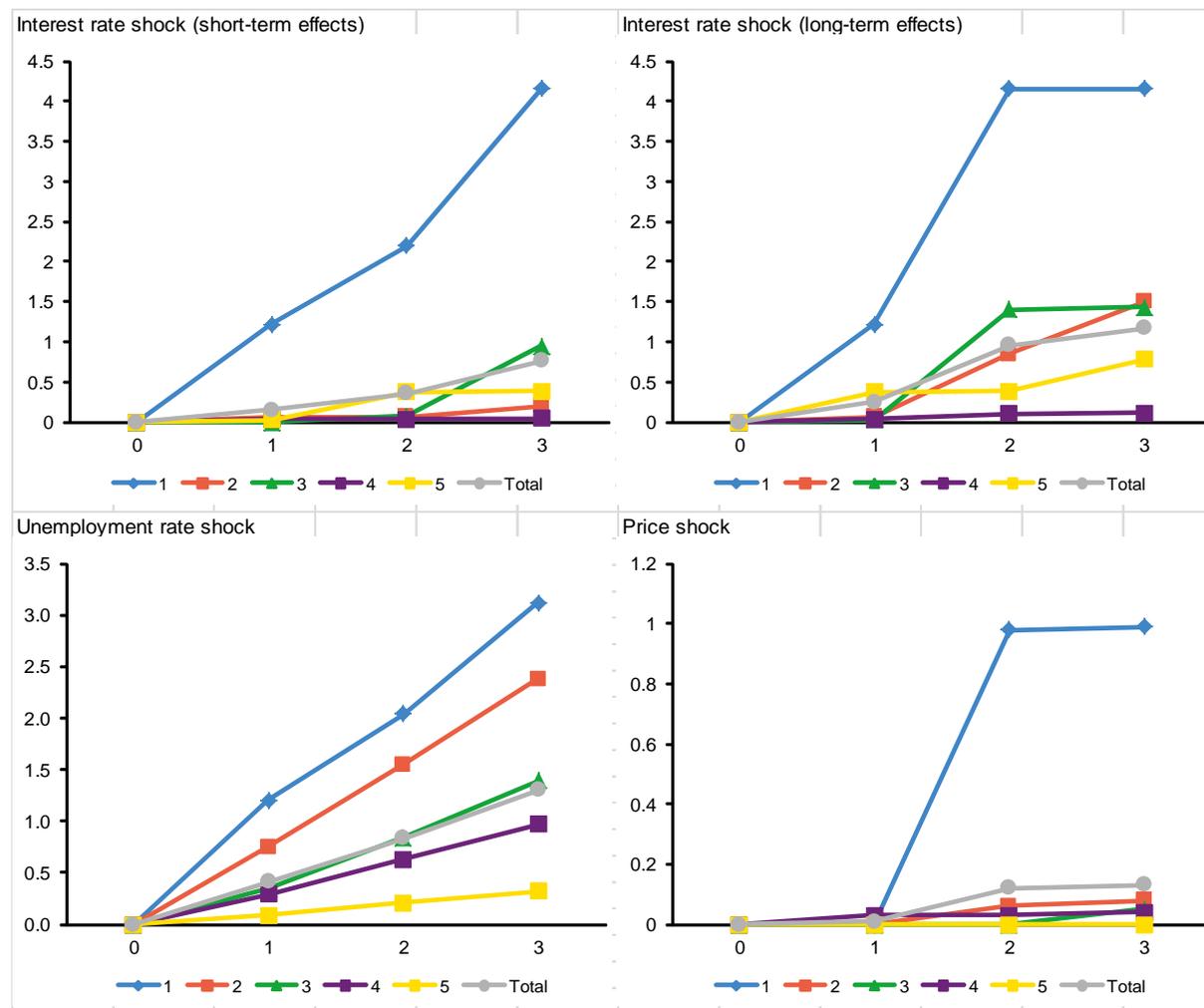
**Figure A4: Change in Average Financial Surplus in Reaction to Shocks by Income Quintiles**  
(CZK/month on y-axis; size of shock on x-axis)



**Source:** HBS 2011 and 2012; authors' calculations.

**Note:** Households with a loan are included.

**Figure A3: Percentage of distressed households by income quintiles in response to shocks**  
(percentage points on y-axis; standard deviations on x-axis)



**Note:** Average percentage of distressed households among households with a loan.

**Source:** HBS 2011 and 2012; authors' calculations.